CHAPTER 1

INTRODUCTION

1-1. Purpose

a. General: This manual provides engineering data and criteria for designing electric power plants where the size and characteristics of the electric power load and the economics of the particular facilit y justify on-site generation. Maximum size of plant considered in this manual is 30,000 kW.

b. References: A list of references used in this manual is contained in Appendix A. Additionally, a Bibliography is included identifying sources of material related to this document.

1-2. Design philosophy

a. General. Electric power plants fall into several categories and classes depending on the type of prime mover. Table 1-1 provides a general description of plant type and related capacity requirements. For purposes of this introduction Table 1-2 defines, in more detail, the diesel plant classes and operational characteristics; additional information is provided in Chapter 7. No similar categories have been developed for gas turbines. Finally, for purposes of this manual and to provide a quick scale for the plants under review here, several categories have been developed. These are shown in Table 1-3.

b. Reliability. Plant reliability standards will be equivalent to a l-day generation forced outage in 10 years with equipment quality and redundancy selected during plant design to conform to this standard.

c. Maintenance. Power plant arrangement will permit reasonable access for operation and maintenance of equipment. Careful attention will be given to the arrangement of equipment, valves, mechanical specialties, and electrical devices so that rotors, tube bundles, inner valves, top works, strainers, contractors, relays, and like items can be maintained or replaced. Adequate platforms, stairs, handrails, and kickplates will be provided so that operators and maintenance personnel can function conveniently and safely.

d. Future expansion. The specific site selected for the power plant and the physical arrangement of the plant equipment, building, and support facilities such as coal and ash handling systems, coal storage, circulating water system, trackage, and access roads will be arranged insofar as practicable to allow for future expansion.

1-3. Design criteria

a. General requirements. The design will provide for a power plant which has the capacity to provide the quantity and type of electric power, steam and compressed air required. Many of the requirements discussed here are not applicable to each of the plant categories of Table 1-1. A general overview is provided in Table 1-4.

b. Electric power loads. The following information, as applicable, is required for design:

(1) Forecast of annual diversified peak load to be served by the project.

(2) Typical seasonal and daily load curves and load duration curves of the load to be served. Example curves are shown in Figures 1-1 and 1-2.

(3) If the plant is to operate interconnected with the local utility company, the designer will need information such as capacity, rates, metering, and interface switchgear requirements.

(4) If the plant is to operate in parallel with existing generation on the base, the designer will also need:

(a) An inventory of major existing generation equipment giving principal characteristics such as capacities, voltages, steam characteristics, back pressures, and like parameters.

(b) Incremental heat rates of existing boiler-turbine units, diesel generators, and combustion turbine generator units.

(c) Historical operating data for each existing generating unit giving energy generated, fuel consumption, steam exported, and other related information.

(5) Existing or recommended distribution voltage, generator voltage, and interconnecting substation voltages.

(6) If any of the above data as required for performing the detailed design is unavailable, the designer will develop this data.

c. Exports team loads.

(1) *General requirements.* If the plant will export steam, information similar to that required for electric power, as outlined in subparagraph c above, will be needed by the designer.

(2) *Coordination of steam and electric power* loads. To the greatest extent possible, peak, seasonal, and daily loads for steam will be coordinated with the electric power loads according to time of use.

Table 1-1. General Description of Type of Plant.

Category	Capacity	TYPE OF POWER	
		No Export Steam	With Export Steam
Primary	Adequate to meet all peacetime requirement.	Purchased electric power to match electric load.	Purchased electric power and steam to match electric load plus supplementary boiler plant to match export steam load.
		Continuous duty diesel plant, Class "A" diesel.	Automatic back pressure steam plant plus automatic packaged firetube boiler to supplement requirements of export steam load.
		Straight condensing boilers and and turbines matched in capacity as units; enough units so plant without largest unit can carry emergency load.	Automatic extraction steam plant boilers and turbines matched in capacity se units and enough units installed so that plant without largest unit can carry emergency load.
Standby	Adequate with prime source to match mobilization needs; or alone to supply emergency electric load and export steam load in case of primary source out age.	Purchased electric power.	Purchased electric power and steam to match electric power load plus supplementary boiler plant.
		Standby diesel plant, Class "B" diesel.	Standby diesel plant with supplementary boiler plant.
	Equal to primary source	Retired straight condensing plant.	Retired automatic extraction steam plant.
Emergency	To supply that part of emergency load that cannot be interrupted for more than 4 hours.	Fixed emergency diesel plant, Class "C" diesel.	None.
		Mobile utilities support equipment.	None.

Table 1-2. Diesel Class and Operational Characteristics.

Class	Usage	Full Load Rating Capability: Minimum Hours	Full Load Rating Capability: Operating Period	Expected Operating Hours: Annually	Expected Operating Hours: First Ten Years
"A"	Continuous	8,000	Yearly	4,000 hours plus	40,000 hours plus
"B"	Standby	8,000	Yearly	1,000 to 4,000 hours	20,000 to 40,000 hours
"c"	Emergency	650	Monthly*	Under 1,000 hours	Under 10,000 hours

*Based on a 30-day month.

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Table-3. Plant Sizes.

Category	Size
Small	o to 2,500 kW
Medium	2,500 kW to 10,000 kW
Large	10,000 kW to 30,000 kW

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Table-4. Design Criteria Requirements.

Class (Plant Category)	Electric Power Loads	Export Steam Loads	Fuel Source and Cost	Water Supply	Stack Emission	Waste Disposal
A (Primary)	A	A	A	A	A	A
B (Standby)	A	N/A	A	N/A	N/A	A
C (Emergency)	critical loads only	N/A	A	N/A	N/A	N/A

A= Applicable
N/A = Not Applicable

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This type of information is particularly important if the project involves cogeneration with the simultaneous production of electric power and steam.

d. Fuel source, and cost. The type, availability, and cost of fuel will be determined in the early stages of design; taking into account regulatory requirements that may affect fuel and fuel characteristics of the plant.

e. Water supply. Fresh water is required for thermal cycle makeup and for cooling tower or cooling pond makeup where once through water for heat rejection is unavailable or not usable because of regulatory constraints. Quantity of makeup will vary with the type of thermal cycle, amount of condensate return for any export steam, and the maximum heat rejection from the cycle. This heat rejection load usually will comprise the largest part of the makeup and will have the least stringent requirements for quality.

f. Stack emissions. A steam electric power plant will be designed for the type of stack gas cleanup equipment which meets federal, state, and municipal emission requirements. For a solid fuel fired boiler, this will involve an electrostatic precipitator or bag house for particulate, and a scrubber for sulfur compounds unless fluidized bed combustion or compliance coal is employed. If design is based on compliance coal, the design will include space and other required provision for the installation of scrubber equipment. Boiler design will be specified as required for NO_x control.

g. Waste disposal.

(1) *Internal combustion plants.* Solid and liquid wastes from a diesel or combustion turbine generating station will be disposed of as follows: Miscellaneous oily wastes from storage tank areas and sumps will be directed to an API separator. Supplementary treating can be utilized if necessary to meet the applicable requirements for waste water discharge. For plants of size less than 1,000 kW, liquid

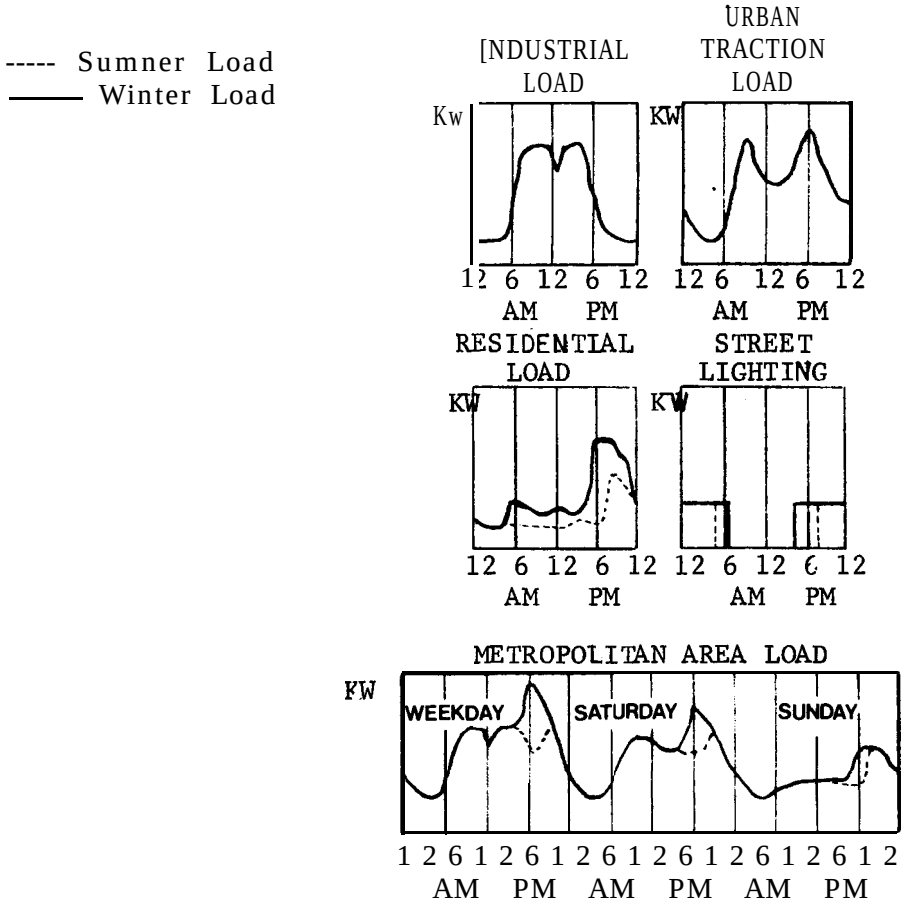

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Figure 1-1. Typical metropolitan area load curves.

oily wastes will be accumulated in sumps or small tanks for removal. Residues from filters and centrifuges will be similarly handled.

(2) *Steam electric stations.* For steam electric generating stations utilizing solid fuel, both solid and liquid wastes will be handled and disposed of in an environmentally acceptable manner. The wastes can be categorized generally as follows:

(a) Solid wastes. These include both bottom ash and fly ash from boilers.

(b) Liquid wastes. These include boiler blowdown, cooling tower blowdown, acid and caustic water treating wastes, coal pile runoff, and various contaminated wastes from chemical storage areas, sanitary sewage and yard areas.

h. Other environmental considerations. Other environmental considerations include noise control and aesthetic treatment of the project. The final location of the project within the site area will be reviewed in relation to its proximity to hospital and office areas and the civilian neighborhood, if applicable. Also, the general architectural design will be reviewed in terms of coordination and blending with the style of surrounding buildings. Any anticipated noise or aesthetics problem will be resolved prior to the time that final site selection is approved.

1-4. Economic considerations

a. The selection of one particular type of design for a given application, when two or more types of design are known to be feasible, will be based on the results of an economic study in accordance with the requirements of DOD 4270.1-M and the National Energy Conservation Policy Act (Public Law 95-619,9 Nov 1978).

b. Standards for economic studies are contained in AR 11-28 and AFR 178-1, respectively. Additional standards for design applications dealing with energy/fuel consuming elements of a facility are contained in the US Code of Federal Regulations, 20 CFR 436A. Clarification of the basic standards and guidelines for a particular application and supplementary standards which may be required for special cases may be obtained through normal channels from HQDA (DAEN-ECE-D), WASH DC 20314.

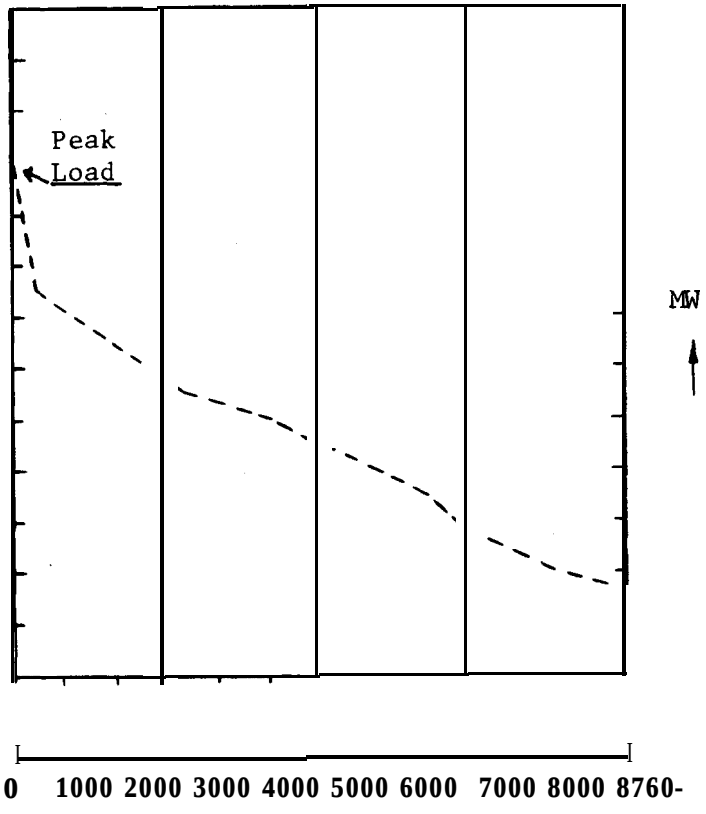

Figure 1-2. Typical annual load duration curve.